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STANLEY-G.I. ELECTRIC MANUFACTURING CO.

PITTSFIELD, MASSACHUSETTS.

BULLETIN No. 249
JUNE 1905

TYPE "Z" TRANSFORMERS

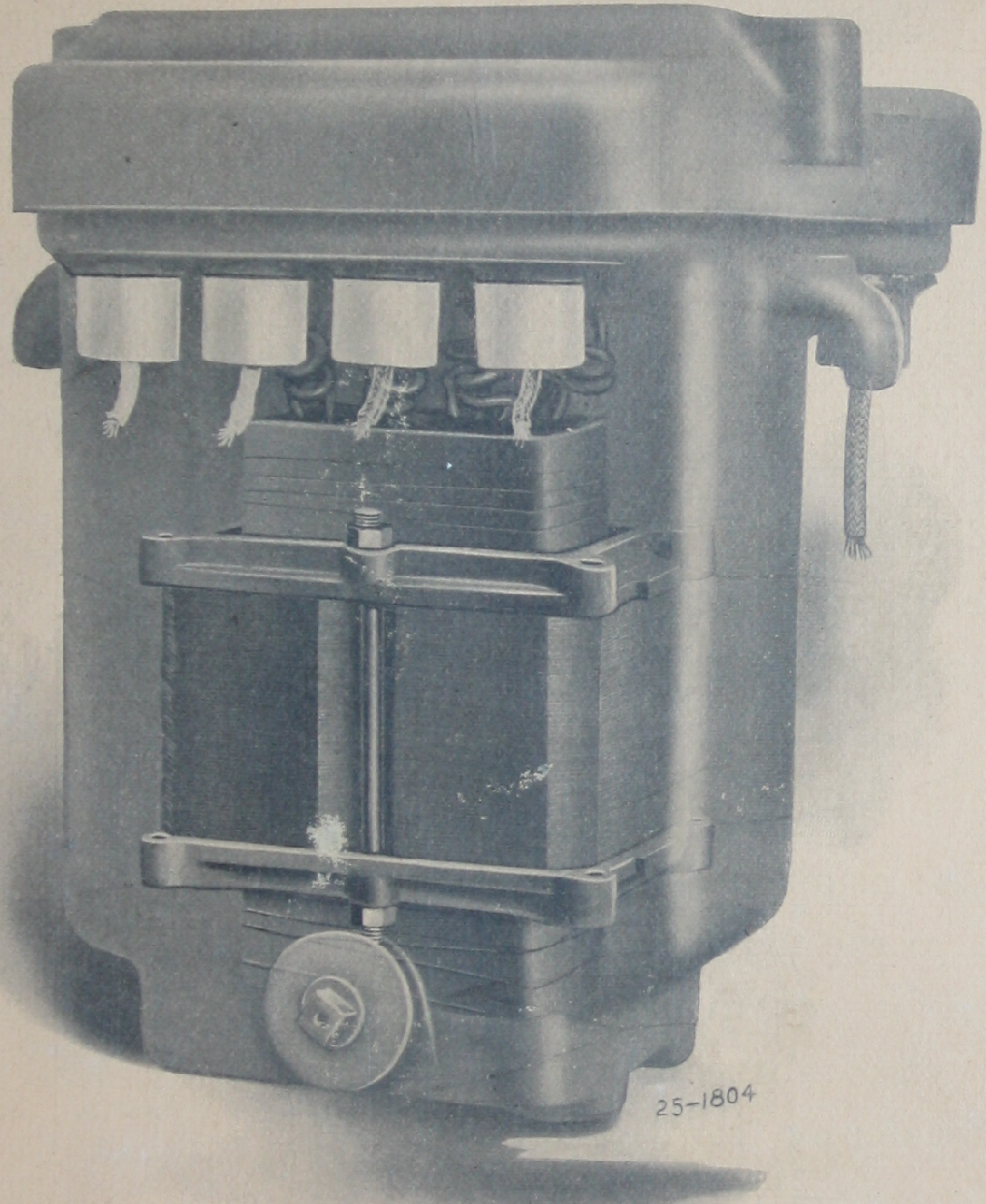

FIG. 1—"PHANTOM" VIEW TYPE "Z" TRANSFORMER

TYPE "Z" TRANSFORMERS

SOME twenty years ago the Stanley Company introduced a transformer which was immediately accepted as the standard of transformer design, so superior was it to anything then in use, and in introducing now the Type "Z" it is felt that it will prove quite as great a boon to central stations as was the first type.

It has been particularly felt by the smaller station managers throughout the country that transformers as recently built are very expensive, where conditions are such that a transformer with a high all-day efficiency is not necessary, that is, in stations where the load is on only four or five hours a day. The Type "Z" has been designed to meet this need for a cheaper transformer, but in its design the hard-and-fast rule of the Stanley Company, of quality first, has not been departed from in order to produce a low-priced transformer.

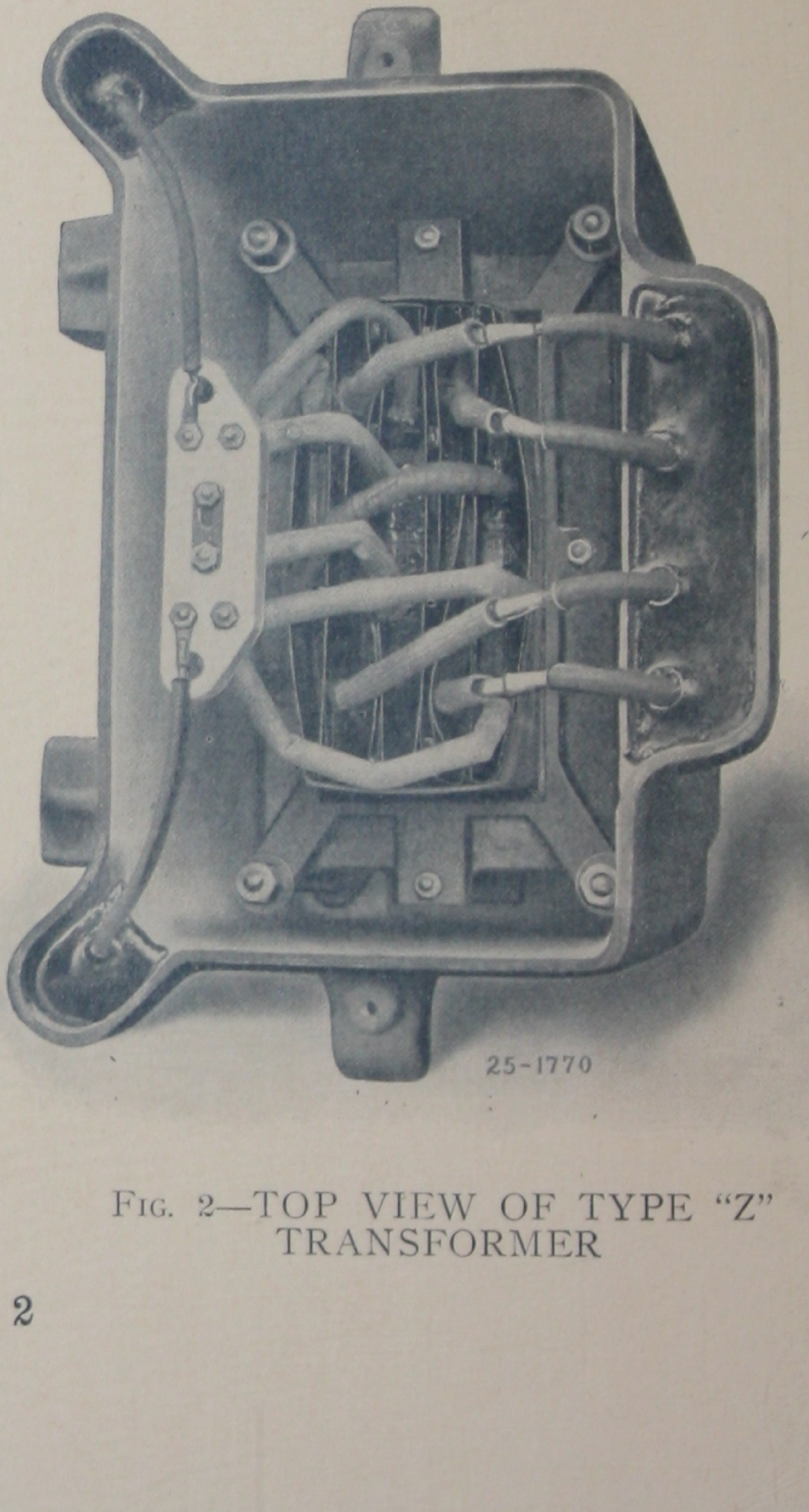

Fig. 2—TOP VIEW OF TYPE "Z" TRANSFORMER

COST OF OPERATION

Some manufacturers still adhere to the old idea that the transformer with the lowest losses is the cheapest, without apparently considering that first cost is quite as important. For example, take two transformers, one with 202 watts total losses and another with 185 watts total losses. The cost of power to supply these losses, figured out according to the well-known rule for figuring the yearly cost of power, is for the first, twelve dollars and seventy-eight cents ($12.78) and for the second, twelve dollars and ten cents ($12.10). If the initial cost of the two transformers were equal, the latter is undoubtedly the cheaper transformer; but suppose the first costs $40.00 and the second $52.00 (these are actual figures from two different makes of transformers), the latter is no longer the cheaper transformer. The first costs $12.00 less than the second, while it costs only $0.68 more per year to operate, and if the transformer is used for only twelve out of twenty-four hours a day the first costs only $0.34 more per year, and this reduction goes on proportionately to the number of hours the transformer is in circuit, while $12.00 is a fixed saving.

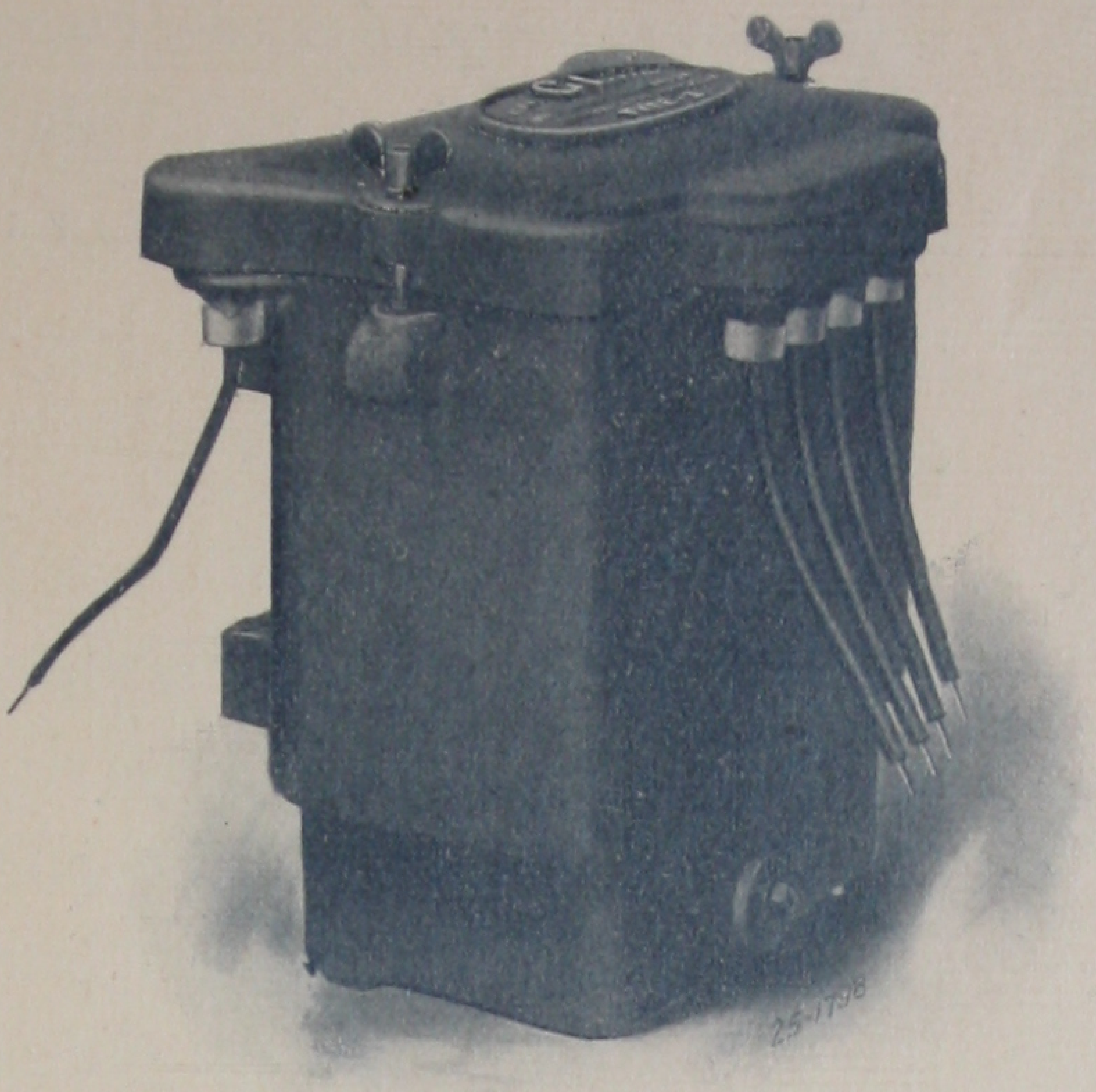

Fig. 3—THE TYPE "Z" TRANSFORMER

This idea of proportioning the losses so as to reduce cost of operation to a minimum without making the first cost of the transformer unnecessarily high, is the basis for the Stanley Company's producing the Type "Z." With this low first cost have been combined all of the good qualities of workmanship for which Stanley apparatus is noted

THE DESIGN OF THE TYPE "Z" TRANSFORMER

CASE

The transformer is set up in a strong but light and attractive cast-iron case, absolutely weather-proof, and therefore well adapted

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to the severe usage of outdoor work. The cast-iron case has the advantage over one built of metal plates, of lower cost for the same quality of case, which is one place in which a considerable saving in cost is effected.

LEADS

The leads are all of extra flexible cable, insulated to withstand 20,000 volts puncture test, although only to be used on a 2,000-volt lighting circuit. They all rise straight above the coils and core, leaving a clear space between the punchings and windings, which insures good insulation between the leads and the transformer proper. This is contrary to the practice of some manufacturers who crowd their transformers into such small space that the leads have to be pressed down upon the core to get them through the bushings in the case. The leads are connected to the coils through small connectors placed immediately above the level of the oil, whereby wicking of the oil by the cables is prevented. This is an idea original with the Stanley Company, and is found to be by far the most successful of any method in use. Heavy porcelain bushings securely leaded in place are provided for bringing the leads through the case.

TERMINAL BOARD

A terminal board of novel design is provided for the primary leads whereby they may be changed to give a wide range of voltage without removing screws or bolts which are liable to be lost or dropped down into the transformer. The board is placed in such a way above the coils, and to one side of them, that the whole interior of the transformer is exposed for examination at any time.

CORE

This is a feature in the design of the Type "Z," in which the Stanley Company has been particularly successful. The same shell-type construction is used, which has been found to be so successful in all large designs. The shell type has an advantage over the core type of presenting a maximum radiating surface to the oil, since the larger part of the coils is inside of the iron instead of completely surrounding it. The temperature of the core is thus maintained as low as possible. The importance of this feature cannot be overestimated, inasmuch as temperature has a marked effect on the so-called "aging" of iron. Aging takes place from heat generated in the core itself, due to hysteresis and eddy current losses, and also from heat imparted to the iron from the windings. If this heating is kept low, and suitable iron is used, there will be little or no aging, which is shown by the fact that the Stanley Company guarantees its Type "Z" Transformers not to increase in core loss more than a few per cent. after several years' operation.

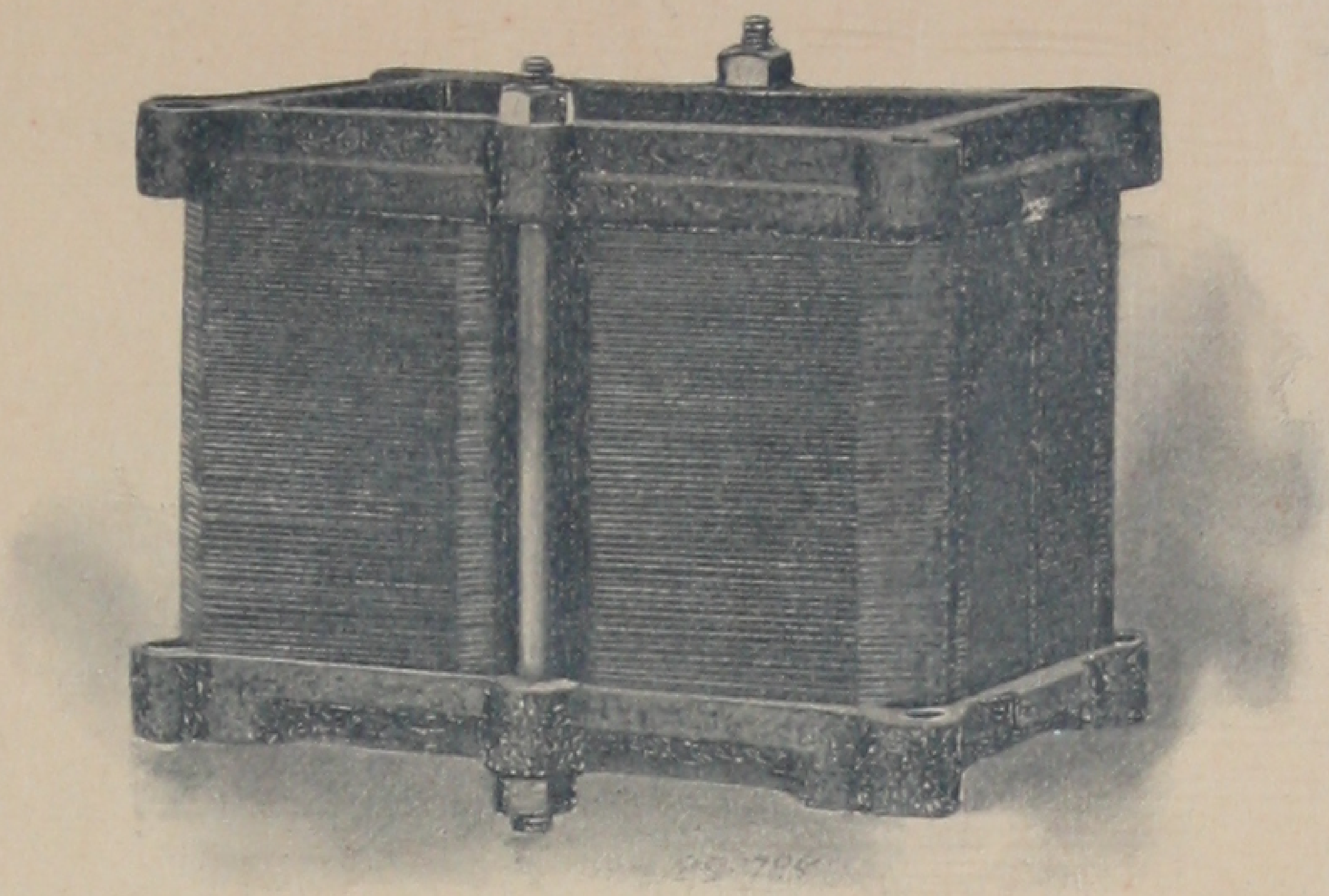


Fig. 4—BUILT-UP CORE OF TYPE "Z" TRANSFORMER

The amount of iron in the core of the Type "Z" Transformer is carefully proportioned to give as low losses as possible with good design, and further than this the very best iron which it is possible to obtain, is used. This iron is made in accordance with our own specifications and is annealed and treated with the utmost care.

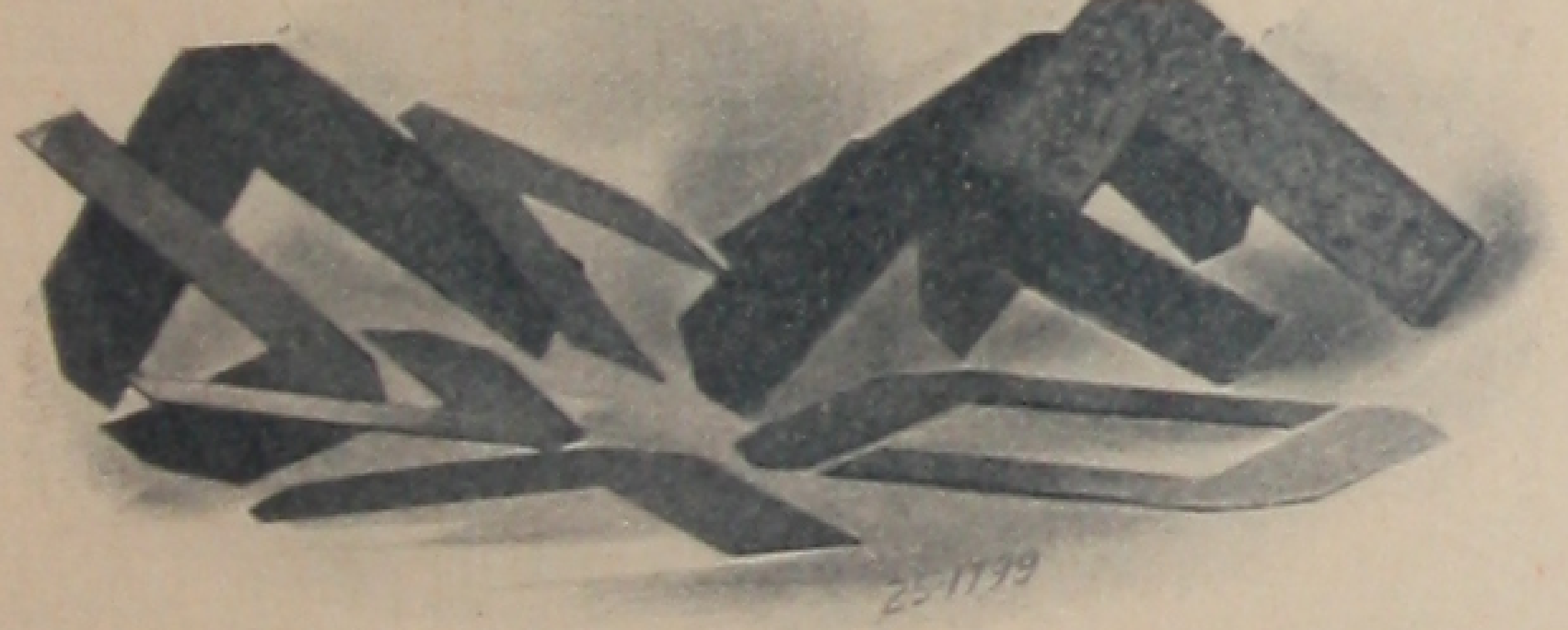


Fig. 5—CORE PLATES

CONSTRUCTION

The shell type of construction has the decided advantage over the core type of a much shorter magnetic circuit, whereby the exciting current is reduced to a minimum.

The coils are of the famous slab-wound type, wound with very few turns per layer and a large number of layers. This insures low voltage between layers and so cuts down space necessary for insulation in other designs. The insulation between layers is of specially treated parchment. A special feature of the design of the coils used in the Type "Z" is that the heavy outside wrappings of tape are entirely done away with. These have been found to be entirely unnecessary in the Type "Z" construction, their place being taken for insulation by treating the coils by an entirely new method of impregnating with fluid insulation of very high di-electric strength, and for mechanical strength by pressing to shape under hydraulic pressure. The close taping on transformer coils has also the disadvantage, besides that of the needless expense involved in putting on these wrappings, of confining the heat of the coils entirely within the copper. In the Type "Z" construction cooling oil is introduced directly into contact with the copper of the windings so that excessive heat, due to momentary overloads, is quickly dissipated and no injurious results are noticed, while a similar overload on ordinary designs would cause a breakdown.

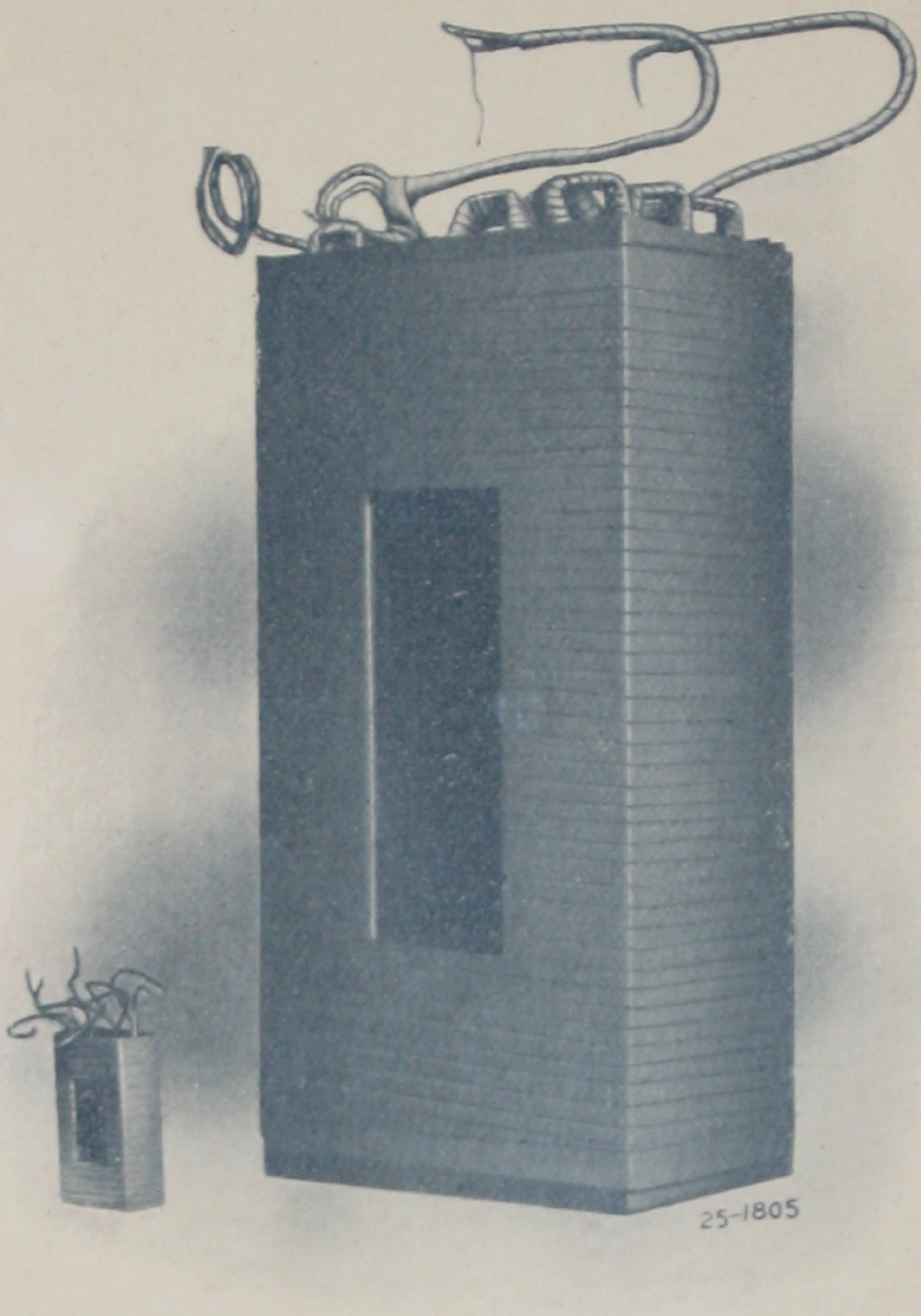


Fig. 6—NOTE THE EXACT SIMILARITY IN CONSTRUCTION OF A 2-KW. TYPE "Z" AND A 300-KW. POWER TRANSFORMER

The coils being very thin, cooling oil is continually circulating past the sides of every layer, and as there are but few turns per layer, no part of the coil is far removed from this cooling agent, while in the core-type construction just the reverse is true. Core-type transformers, with their coils placed horizontally, one above the other, present only their inside and outside layers to the oil, which is carefully excluded from direct contact with the windings by the heavy taping previously mentioned. Since these coils, as well as those of the slab type, must be wound with few turns per layer to insure low voltage, it is evident that practically the whole winding, with the exception of the outside layers, does not come into contact with the oil at all.

In the case of core-type coils wound with the primary superimposed on the secondary, this heating of the inside of the coils is very great, since radiation to the oil must all take place through the coils toward the outside layers. Much more space for insulation is necessary in this construction than in the Type "Z," thus entailing needless expense.

Some manufacturers of core-type transformers claim that the increase of resistance method of measuring temperature rise in the windings is not a true indication of their maximum temperature, since this method shows only average and not maximum heating. The coils of the Type "Z" Transformers are so designed, however, that there is absolutely no temperature in the windings that is not accurately shown by the increase of resistance, and the Type "Z" is guaranteed not to have a maximum temperature greater than the temperature in any other part of the coil.

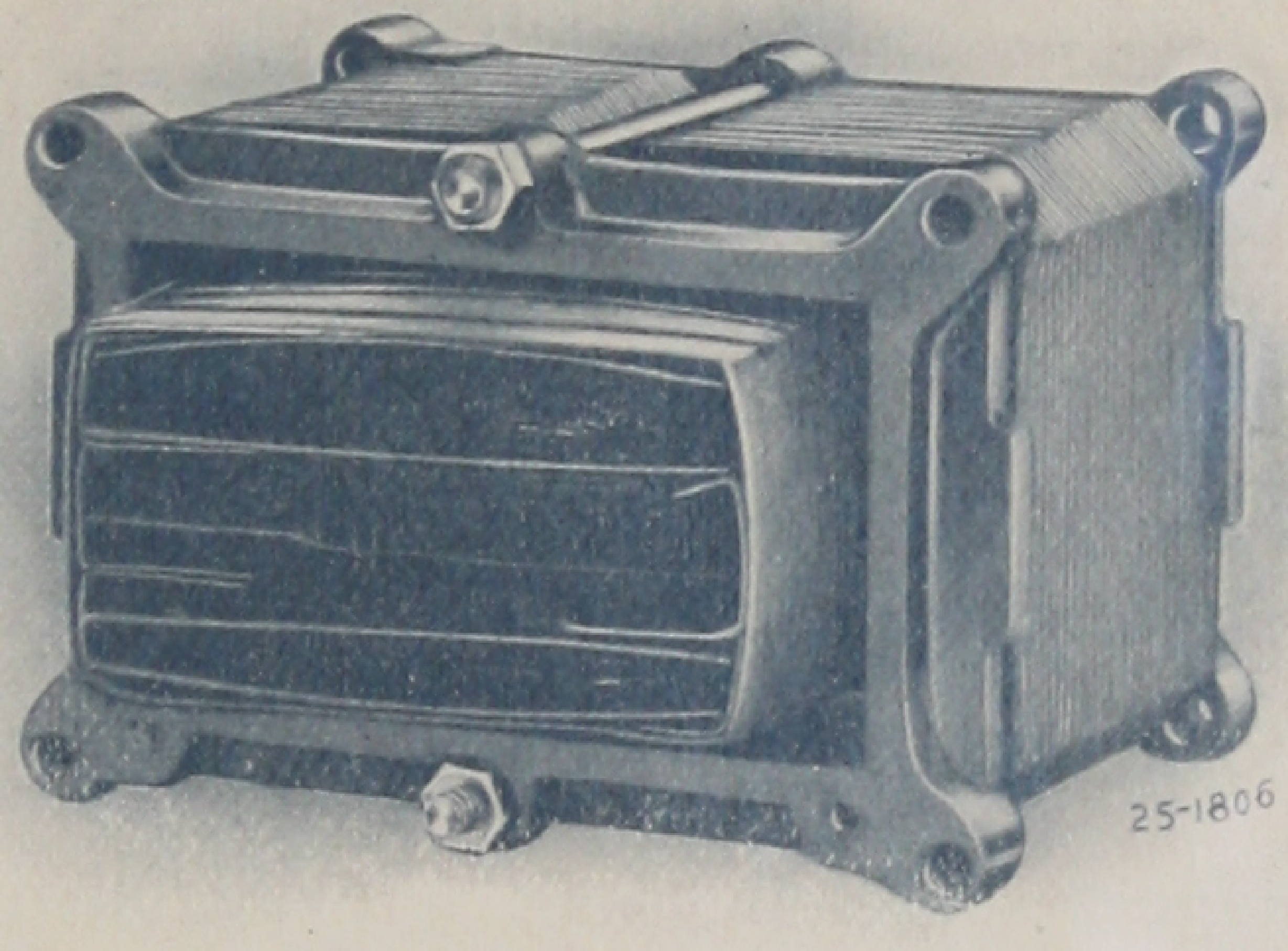


Fig. 7—SHOWING PERFECT INSULATION ON COILS OF TYPE "Z" TRANSFORMER

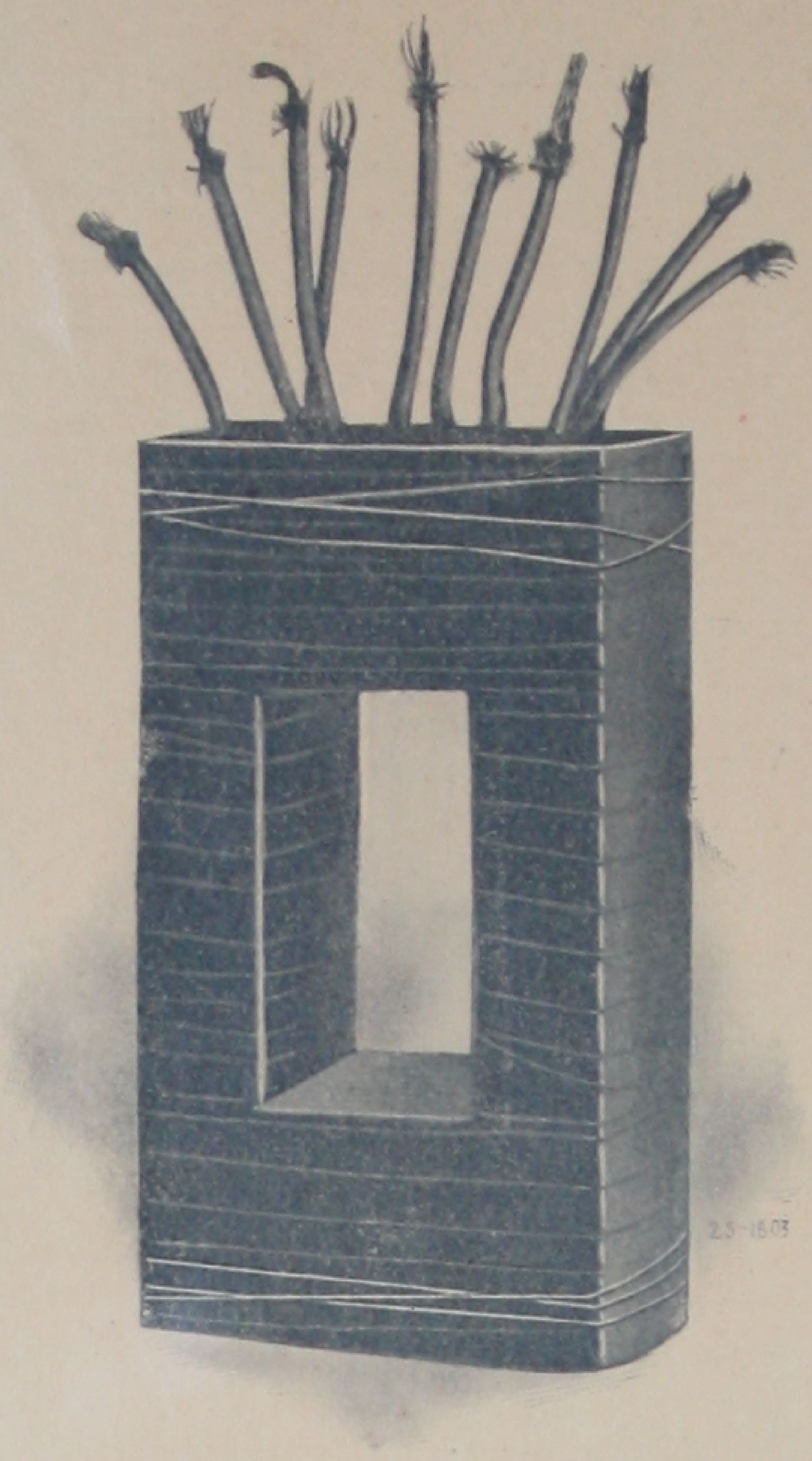


Fig. 8—A SET OF "Z" TRANSFORMER COILS READY FOR IRON

The reason given, that only part of a shell-type coil is exposed to the oil, so leaving a maximum temperature much above the average, must appear much more applicable to the core-type coil itself. As noted above, the inside of the coil is removed to some considerable distance from the oil and so is of necessity very much hotter than its outside layers.

It may be noted here that all manufacturers of the core type transformers adopt the shell-type construction for large high-voltage power transformers, as they find this the only practicable method of insulating the windings and also of dissipating the heat due to the transformer load. These manufacturers claim that oil ducts are introduced with the windings of the large transformers, but that this construction is not possible in the small types on account of the space they occupy. Particular attention is called to the fact that Type "Z" Transformers are designed with these oil ducts and are identical in construction with the very largest power transformers built. (See Fig. 14).

In case of damage to the windings of a shell-type transformer, due to lightning or other cause, but one coil may be damaged, leaving the others intact, which is impossible in the core type of construction. In the core type, especially those in which the primary and secondary are superimposed, a breakdown in one usually causes a breakdown in the other, and this will frequently take place in the center of the coils, due to the greater heat at this point. Since primary and secondary coils are wound in one, the complete set of windings is thus rendered useless.

INSULATION

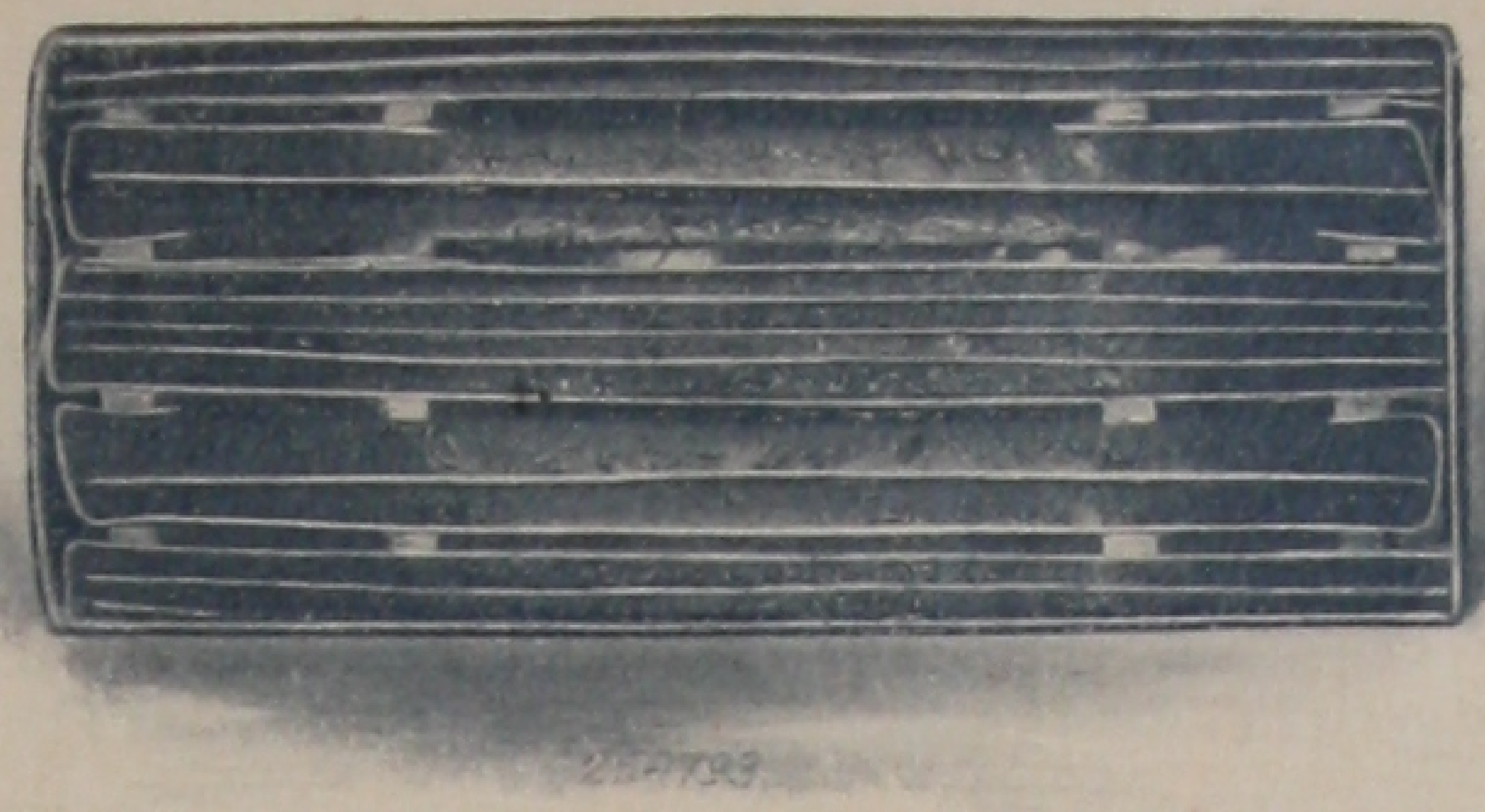


Fig. 9—SHOWING OIL DUCTS

The insulation of the Type "Z" Transformer is one of its distinctive features. As mentioned elsewhere, all taping on the coils is done away with, oil taking its place. The thin slab coils are set up with specially prepared partitions between them, so arranged that a free circulation of the oil is permitted between the coils themselves and also between the coils and partitions. The coils are completely protected on the edges by shoes of the same material as is used in the partitions, and as an additional precaution the corners of the coils are protected by heavy oiled muslin. (See Fig. 10). These pieces are punched to shape, insuring absolute uniformity in size. The set of coils is then surrounded completely by sheets of insulation, and this is taped rigidly in place, leaving the coils very firmly set up in the core. It should be noted that none of these insulating partitions is placed so as to obstruct free circulation of oil through every part of the complete transformer. The insulation on the leads is formed to shape and slipped over the terminals of the coil extending from above the level of the oil back into the winding. Trouble is never experienced from Type "Z" leads grounding on the core and short circuiting the coils.

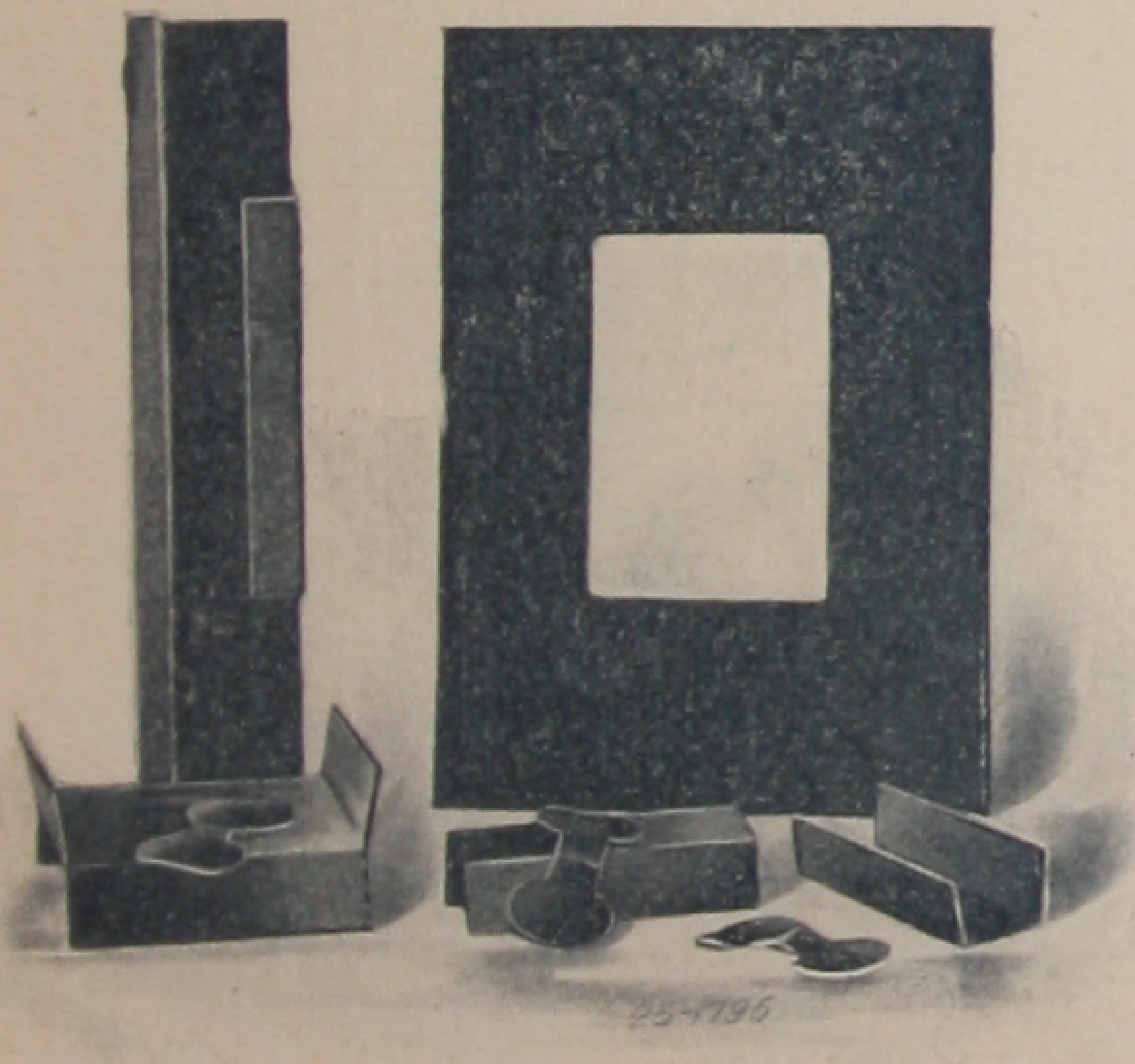


Fig. 10—INSULATING MATERIAL

All the insulating materials used in Type "Z" construction have the peculiar property of increasing in dielectric strength, with high temperature rather than diminishing, and there is absolutely no danger of the partitions or other parts of the insulation disintegrating in the heated oil, which is a very common fault with the insulation of many other makes of transformers.

OIL

The oil used in the Type "Z" is the highest grade of transformer oil the Stanley Company has been able to obtain, after several years spent in experimenting with every known make. It has a very high flashing point and a burning point many degrees higher. It is thoroughly treated to expel moisture, and the importance of this cannot be overestimated. Our laboratory tests show that a few drops of water, in several hundred gallons of oil, reduce the di-electric strength 75 per cent.

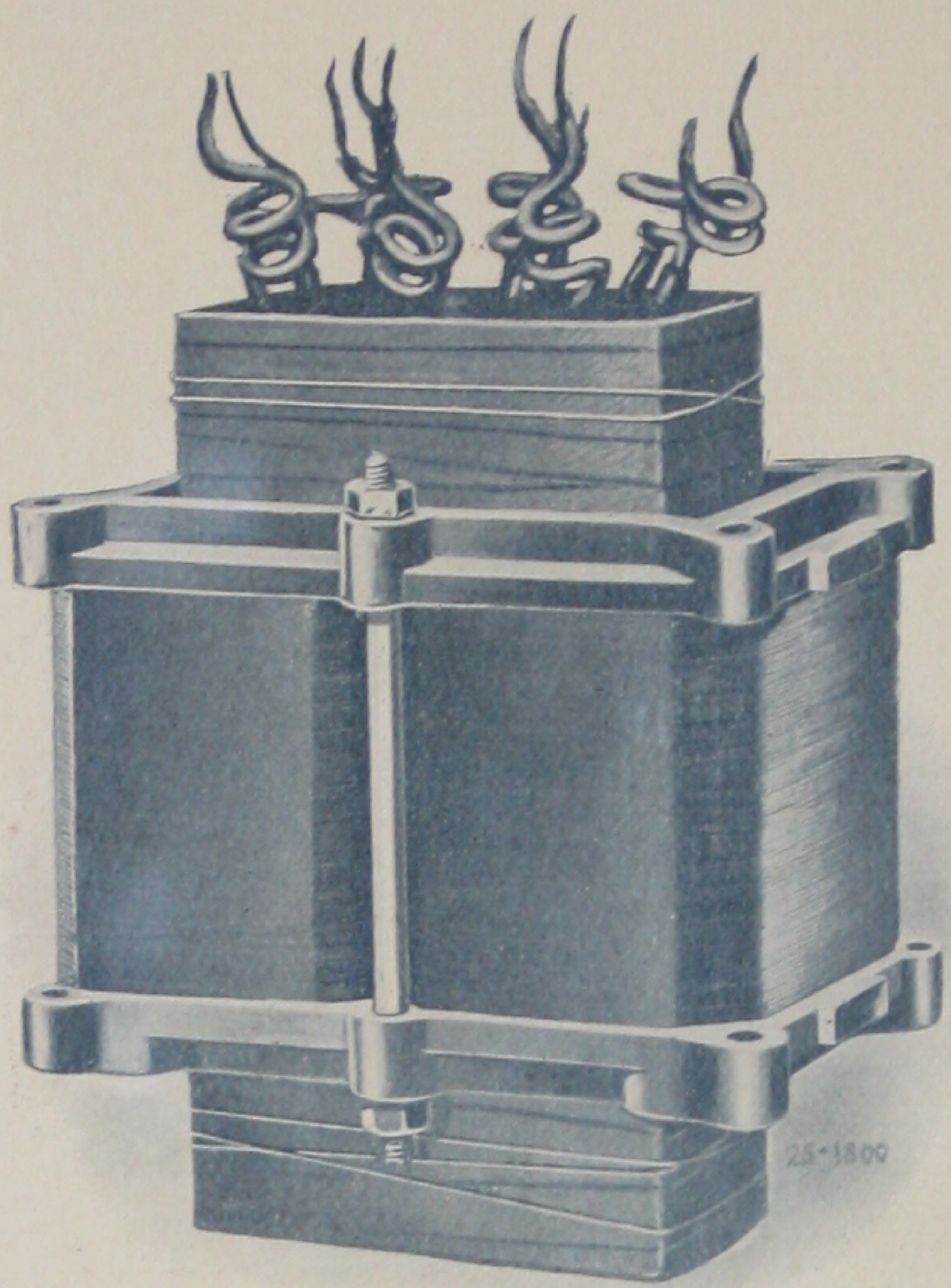


Fig. 11—ASSEMBLED VIEW OF COILS AND CORE

LOSSES

CORE LOSS.

Particular attention is drawn to the fact that Type "Z" core losses are as low as is consistent with low first cost and good design, and, moreover, they are all based on sine wave measurement.

COPPER LOSS.

The amount of copper in the windings is also proportioned to give low cost of maintenance without increasing the initial cost disproportionately. The windings of all (with the exception of the very smallest sizes) are of copper strip or ribbon which takes less room than wire, thus enabling a saving of space and hence initial cost. Strip winding also has the advantage over ordinary wire windings in the larger sizes of being easily laminated. The large sizes of Type "Z" Transformers are built with two or three

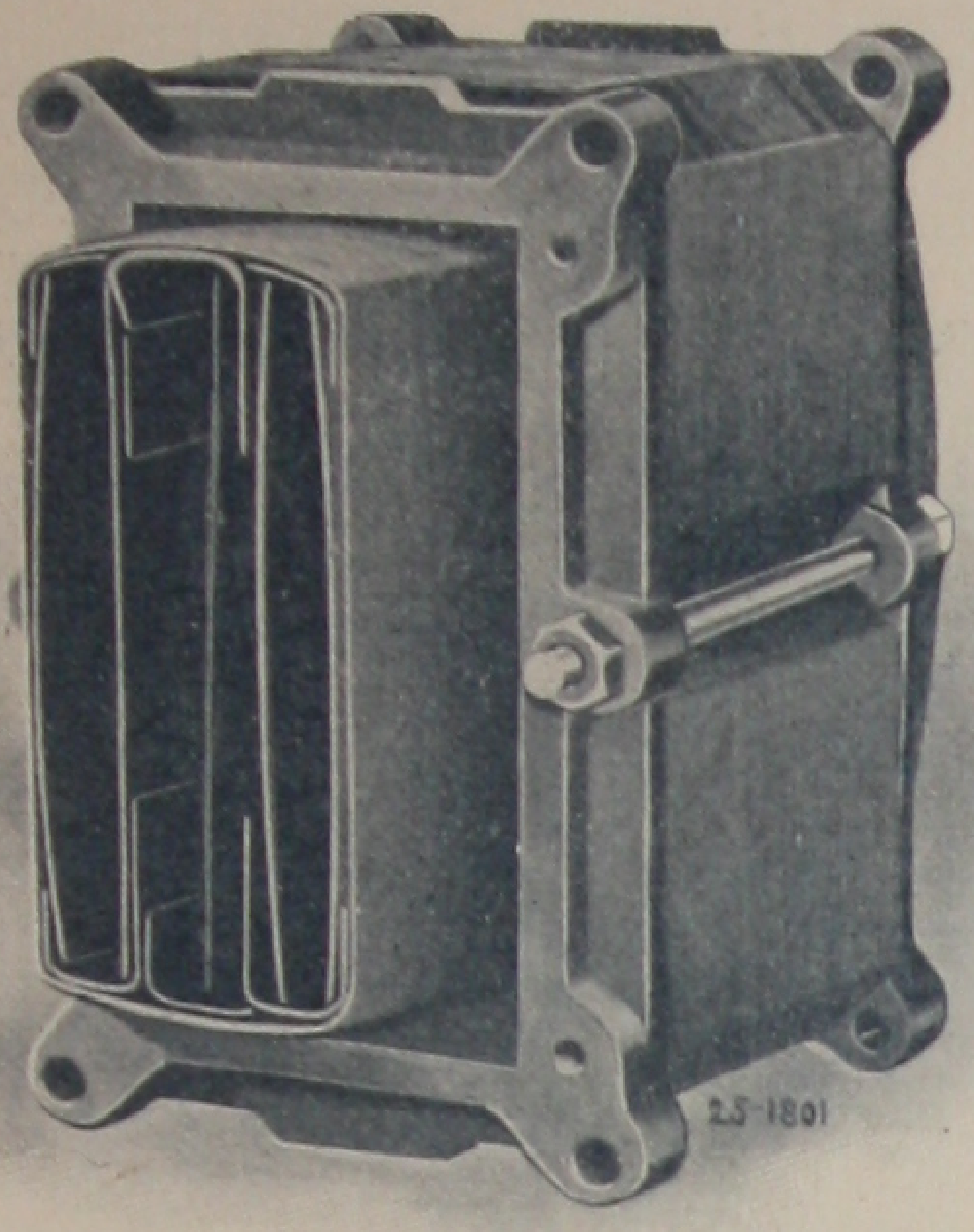


FIG. 12—SHOWING PERFECT INSULATION ON COILS OF "Z" TRANSFORMERS

strips of copper, in parallel, with insulation between, whereby eddy current losses are cut down just as the eddy current losses in the core are kept down by building it of laminations insulated with japan.

REGULATION

The interleaving of primary and secondary coils is the only successful method of securing good regulation in a transformer. By regulation is meant the drop in voltage between no load and full load, that is, if a transformer has a 2% regulation, its secondary, as wound to deliver 110 volts will drop to 107.8 volts when the load is thrown on. Regulation depends upon the loss in the windings and also on the leakage flux, and to maintain this regulation as high as possible a proper relation must exist between these two. This fact has received careful attention in the design of Type "Z" Transformers. A constant voltage between no load and full load insures a steady light to the customer and a long life for the lamps.

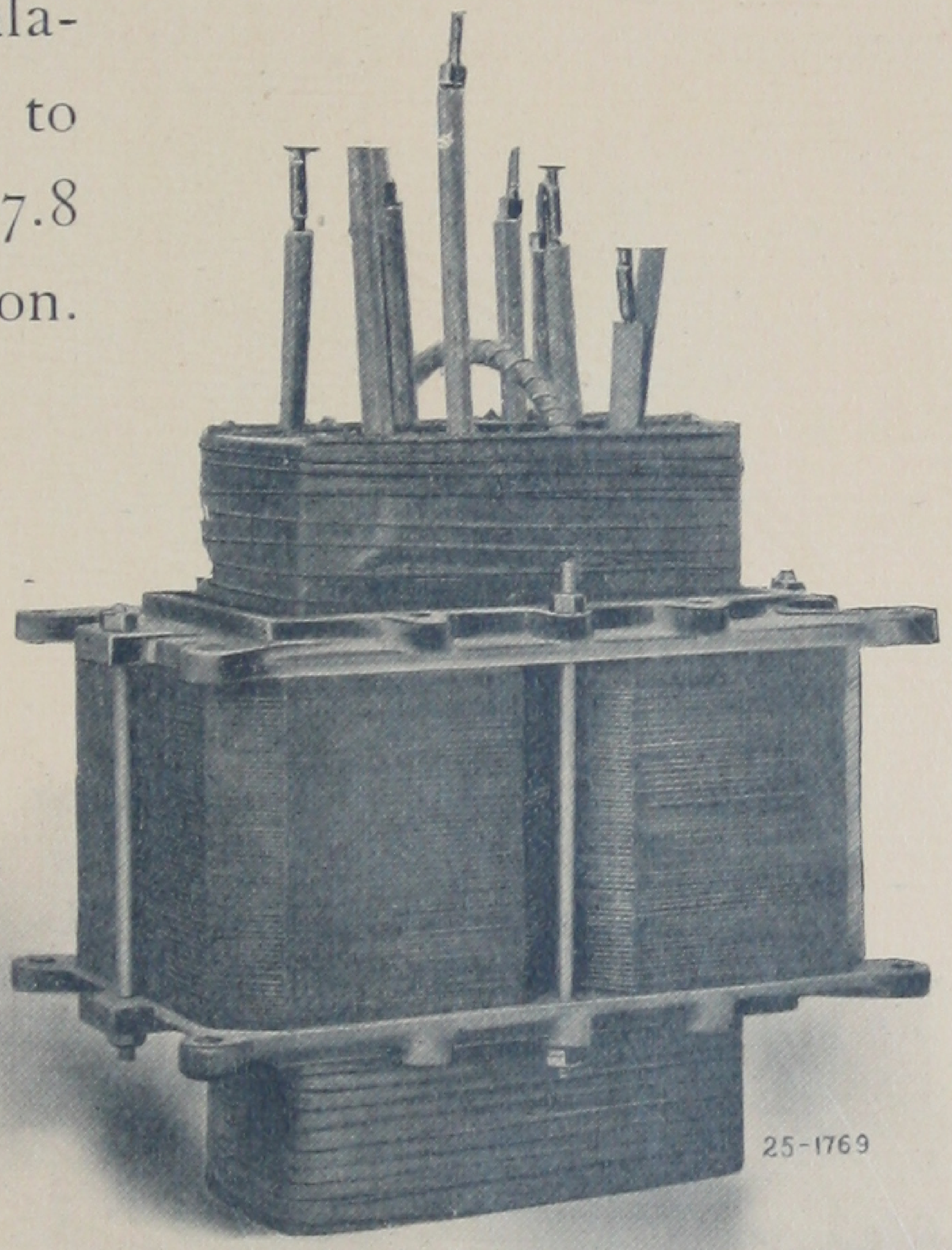


FIG. 13—SET OF TYPE "Z" CORES READY TO GO INTO CASE, SHOWING INSULATION OF LEADS AND TERMINALS FOR CONNECTING TO TERMINAL BOARD

PERFECTION IN DESIGN AND WORKMANSHIP

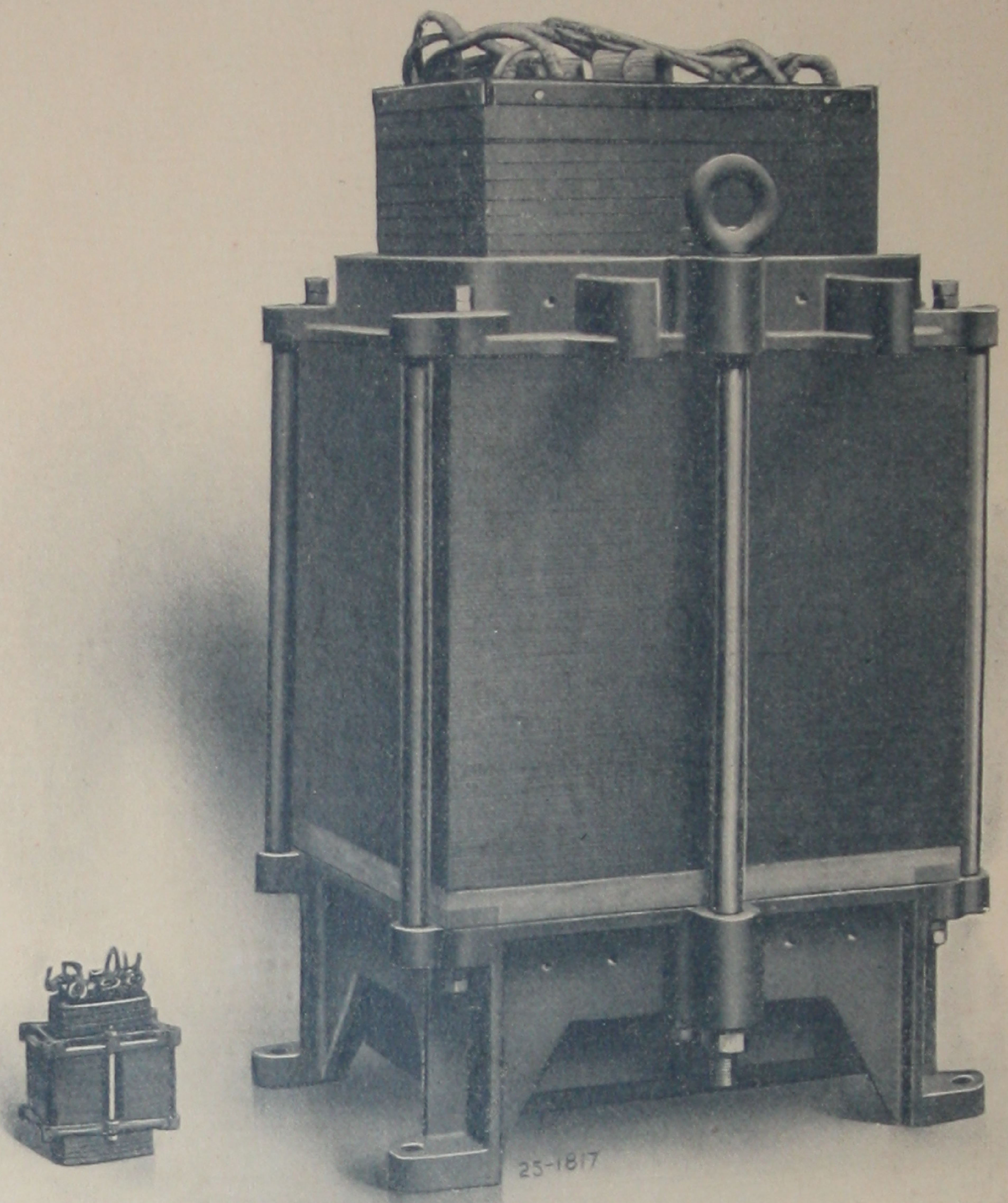
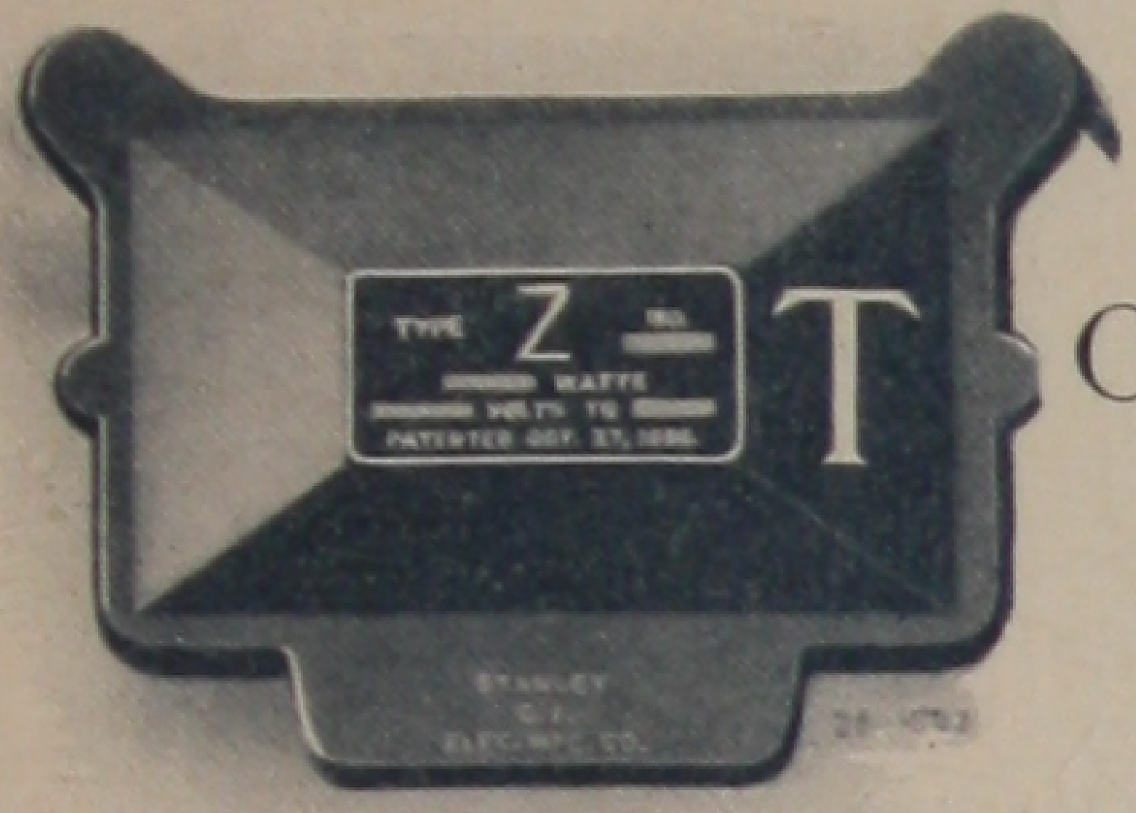


Fig. 14—THIS CUT SHOWS SIMILARITY BETWEEN FINISHED INTERIOR OF TRANSFORMERS THE COILS ARE SHOWN IN FIG. 6

The same standard of excellence in design and workmanship will be noticed in the Type "Z" that characterizes all Stanley apparatus. It was due to the ability of this company's engineers to build large high-voltage transformers that transmission lines of 100 and 200 miles on the Pacific Coast were made possible, and the experience gained in their construction for the past ten years insures the purchaser of the Type "Z" a transformer second to none.

The same shell type of construction is used in both the Type "Z" and the large power transformers, the same insulation is used, the same oil ducts are introduced; and every part entering into the construction of a Type "Z" is as carefully inspected as though the transformer were for 1,000-kw. instead of 1-kw.



TO give some idea of the absolute reliability of the Type "Z" Transformer, the following data from a test run on a 3-kw. transformer at the Pittsfield Works are given:

A 3-kw. Type "Z" was put on test in the Testing Department with normal voltage impressed on the primary and double full-load current taken from the secondary, which it withstood over 450 hours before burning out; in other words, this Type "Z" Transformer ran for 22½ days, at 24 hours a day, on a 100% overload. If the transformer had been used only 6 hours a day and it had started each day's run at the temperature of the day before, an entirely imaginary condition in actual practice, it would have run on double load for 75 days before burning out.

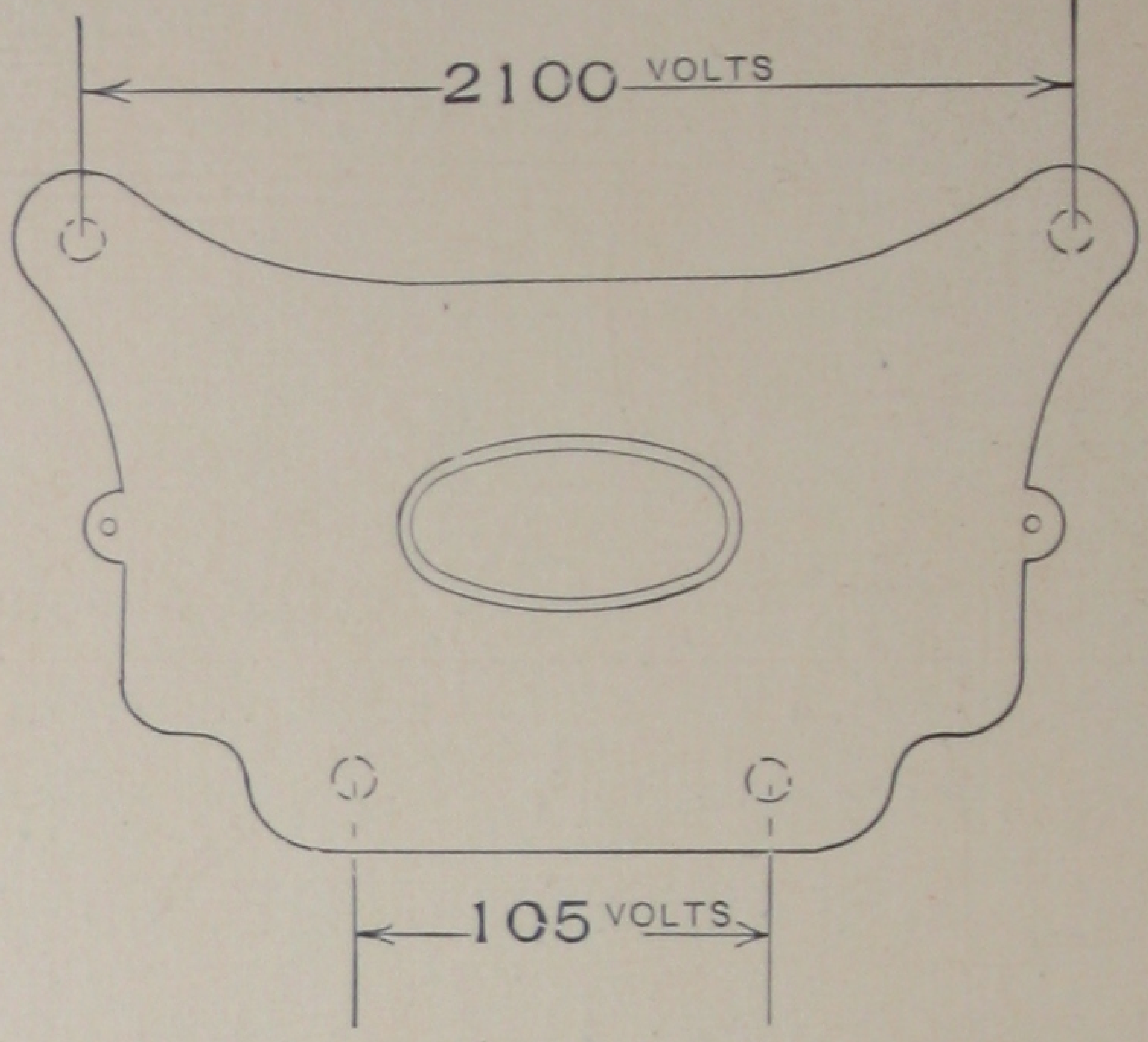
It will be well for station managers or buyers to investigate these remarks.

In view of the price at which the Type "Z" is sold, and also the guarantees which are given, this transformer must soon receive universal recognition.

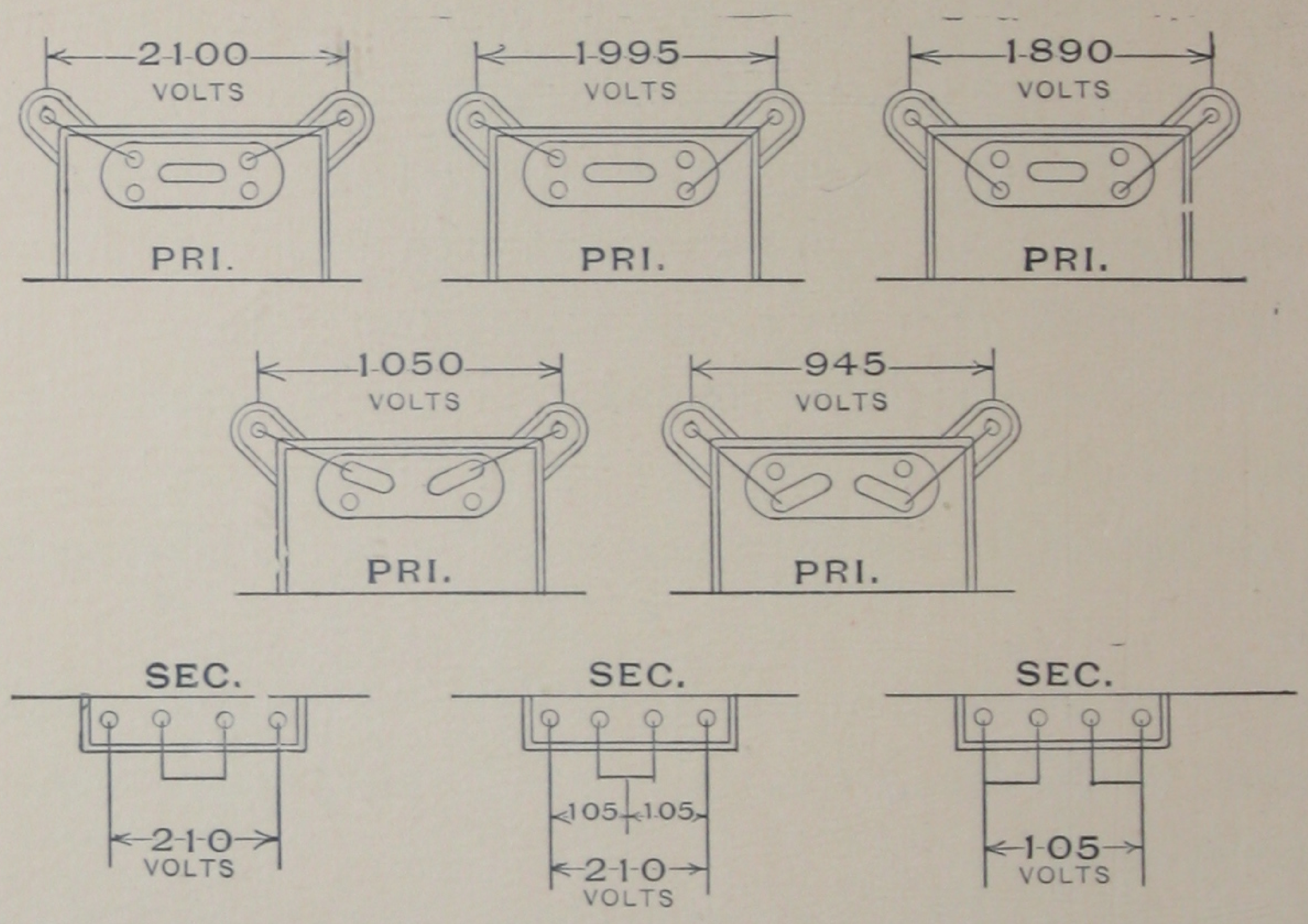
The covers of all Type "Z" Transformers bear the Stanley-G. I. trademark, a guarantee of excellence for each transformer.

CONNECTIONS FOR TYPE "Z" TRANSFORMERS

For Sizes .6, 1 and 1.5 KW.



For Sizes 2 KW. to 30 KW.



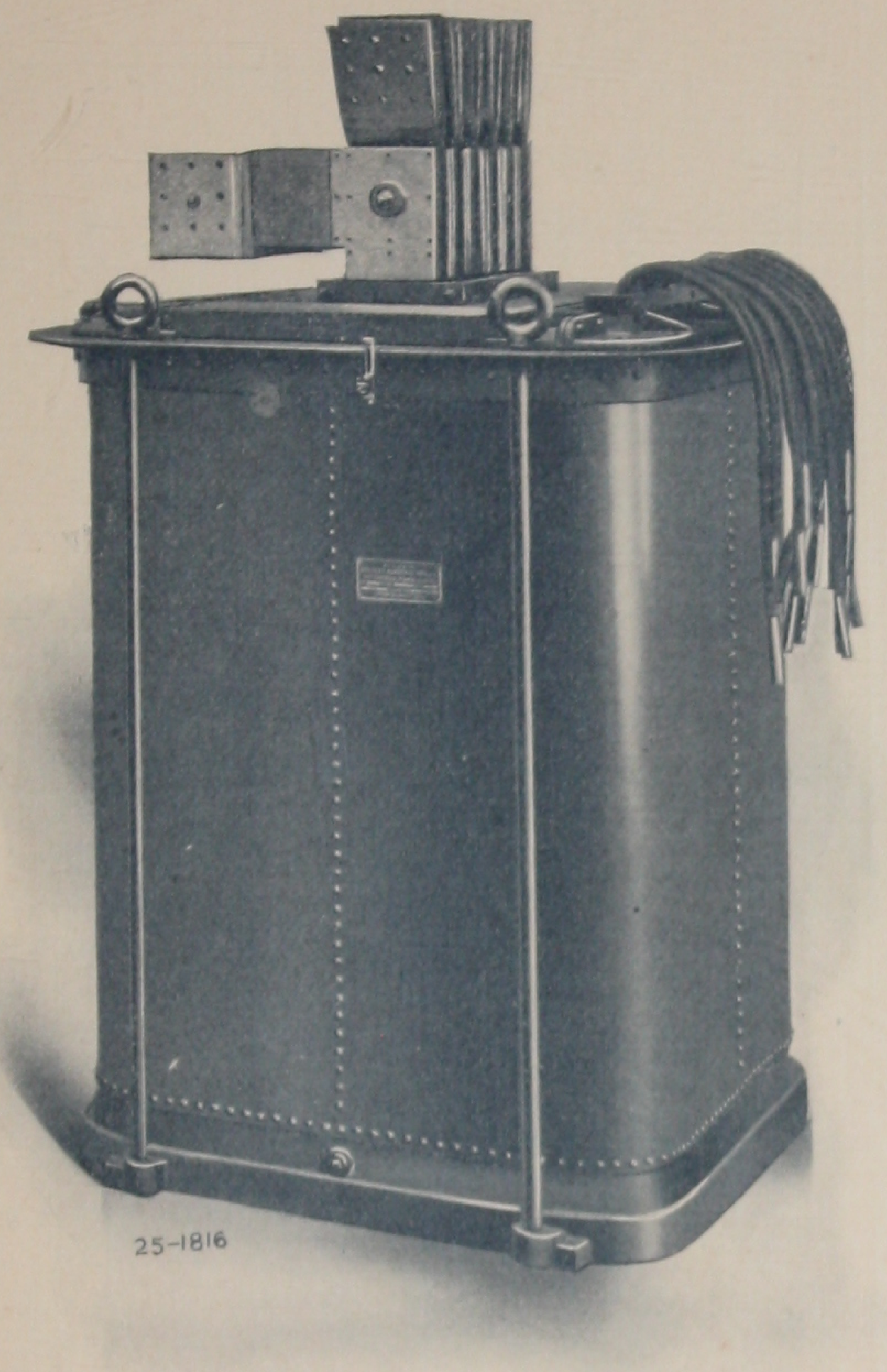
All transformers will be shipped with primary coils connected in series for the higher primary voltage, and the four secondary terminal leads will be left unconnected.

For any other voltage connect the primary and secondary coils in accordance with above diagrams.

The secondary leads may be connected in series or parallel regardless of the primary connections.

LARGEST TRANSFORMER IN THE WORLD

Built for the Pittsburgh Reduction Company, Niagara Falls, N. Y.



Secondary Current 80,000 Amperes.
Secondary E. M. F. 25 to 50 Volts.
Primary E. M. F. 2200 Volts.
Frequency 25 Cycles.

Floor space 86½ inches x 86½ inches; Height over all, 11½ feet.

Gross weight with oil, 50,000 pounds.

Suitable taps are brought out from the primary winding to an oil-type regulator, whereby the secondary voltage may be varied in small steps between maximum and minimum.

LIST PRICES OF TYPE "Z" TRANSFORMERS

KW. Capacity.	No. Lights.	Net Weight Without Oil Lbs.	Gallons of Oil	Shipping Weight.		List Price.*
				Boxed with Oil, Lbs.	Boxed with Oil and Cutouts, Lbs.	
.6	18	70	1.125	103	120	$31.00
1.	20	75	1.25	108	125	34.00
1.5	30	81	1.5	116	132	45.00
2.	40	106	2.	152	168	55.00
2.5	50	110	2.	158	174	64.00
4.	80	161	2.75	222	238	80.00
5.	100	200	4.	262	278	91.00
7.5	150	260	6.5	342	358	130.00
10.	200	314	7.	406	422	160.00
15.	300	448	8.5	590	606	230.00
20.	400	600	9.	742	758	300.00
25.	500	697	18.	1035	1050	400.00
30.	600	735	18.	1075	1090	500.00

*Discounts on application.

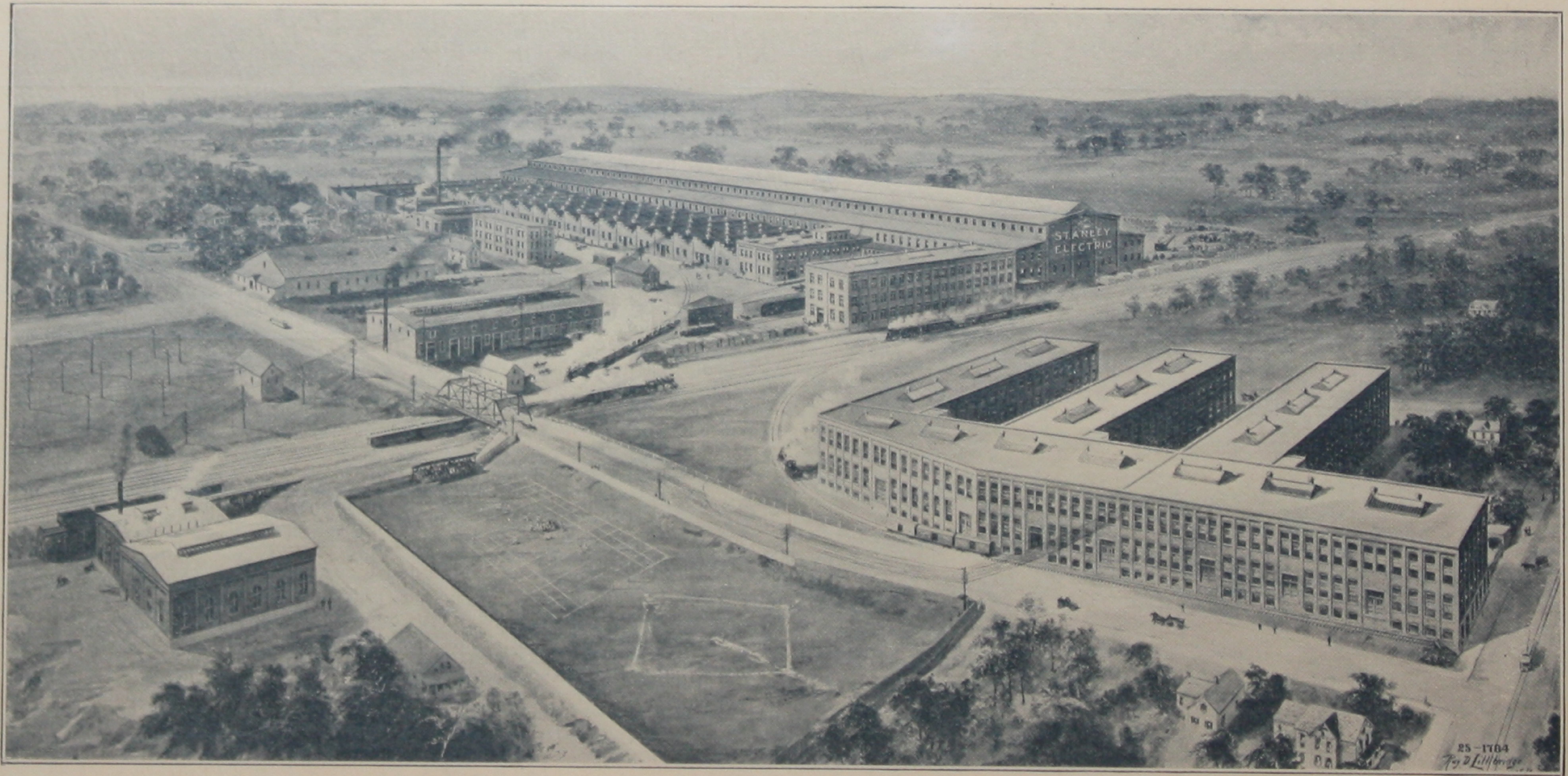
GUARANTEES OF TYPE “Z” TRANSFORMERS

1050—2100 and 105—210 Volts. 60 Cycles.

KW. Capacity	Core Loss	Copper Loss	Regulation Per Cent.	Efficiency, Per Cent.			
				Full Load	¾ Load	½ Load	¼ Load
.6	33	20	3.4	91.9	91.3	88.8	81.4
1.	38	31	3.3	93.5	93.1	91.6	86.2
1.5	45	48	3.2	94.2	94.0	92.9	88.7
2.	52	55	2.8	94.9	94.8	93.7	90.0
2.5	59	66	2.7	95.2	95.1	94.3	90.8
4.	79	90	2.5	95.9	95.9	95.2	92.2
5.	90	112	2.5	96.1	96.1	95.5	92.8
7.5	115	139	2.0	96.8	96.7	96.2	93.8
10.	140	171	1.8	97.0	97.0	96.5	94.3
15.	185	250	1.7	97.2	97.2	96.8	94.9
20.	215	300	1.7	97.5	97.5	97.2	95.5
25.	238	375	1.7	97.6	97.7	97.4	96.0
30.	270	428	1.6	97.7	97.8	97.6	96.2

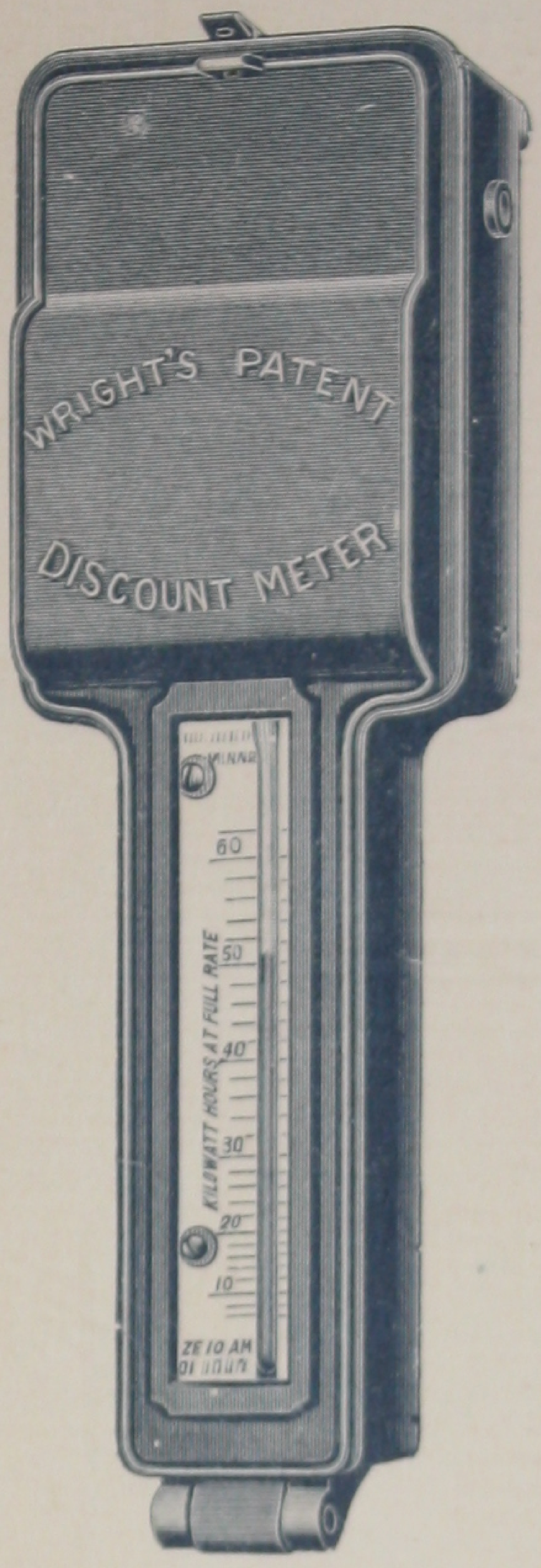
1050—2100 and 105—210 Volts. 133 Cycles.

.6	25	20	3.5	93.1	91.	89.3	82.8
1.	29	31	3.4	94.4	94.3	94.1	89.9
1.5	34	48	3.3	94.8	94.8	94.5	91.5
2.	39	55	2.9	95.5	95.5	95.0	92.1
2.5	44	66	2.8	95.8	95.8	95.3	92.9
4.	59	90	2.7	96.4	96.4	95.8	93.9
5.	68	112	2.7	96.5	96.6	96.3	94.3
7.5	86	139	2.4	97.0	97.1	96.9	95.2
10.	105	171	2.1	97.3	97.4	97.1	95.5
15.	139	250	1.9	97.5	97.6	97.4	96.0
20.	161	300	1.9	97.7	97.8	97.7	96.5
25.	179	375	1.9	97.8	98.0	97.9	96.9
30.	203	428	1.8	97.9	98.1	97.3	97.0



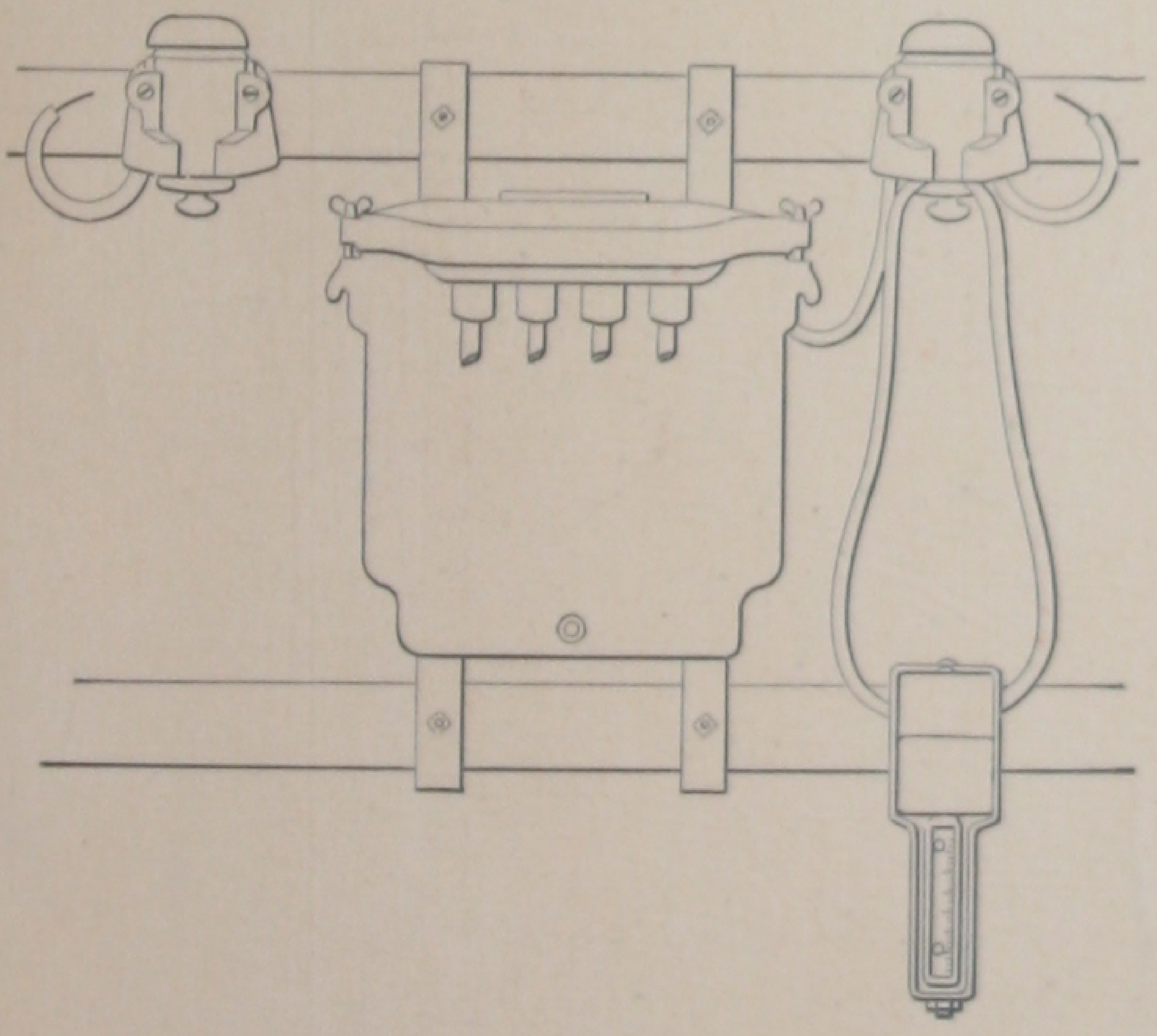
WORKS OF THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY,
PITTSFIELD, MASS.

THE WRIGHT DISCOUNT METER.



In order to thoroughly understand the operating conditions of a transformer, it is necessary to know the maximum load. This can be best and most easily determined by means of a Wright Discount Meter connected in series with the primary winding of the transformer. The cut-out plug of the "Z" Transformer is made especially to facilitate the use of such a meter. The plug is made entirely of porcelain, with the exception of the binding screws, which hold the fuse, and the contact clips. In order to connect in the Discount Meter, one of the fuse plugs is removed and a plug, connected to the terminals of the meter, is inserted.

The meter can be provided with hooks or similar contrivances, so that it may be placed quickly in position on the cross-arm or pole. No special devices are necessary to make the connection. This meter is strongly built and may be left in circuit continuously without injury.



SHOWING MANNER OF USING WRIGHT DISCOUNT METER

One of the most prominent electric light companies of the United States has just placed an order for 10,000 Wright Discount Meters after having demonstrated to their entire satisfaction the excellence of the Meter in actual use. This makes a total of over 16,000 Wright Discount Meters ordered by this one company alone since January 1, 1905.

THE Stanley Electric Manufacturing Company and the General Incandescent Arc Light Company have consolidated. The corporate name of the combined interests is:

STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY.

The Stanley Company, as engineers and manufacturers of the well-known S. K. C. apparatus, turn out only such machinery as is markedly superior in points of engineering and manufacture over ordinary electrical apparatus.

The S. K. C. system comprises the latest developments and improvements in Generators, Transformers, Rotary Convertors, Motor Generator Sets, Switchboard Apparatus, Induction Motors, Etc.

The General Incandescent Arc Light Company have been known as builders of the high-grade G. I. Arc Lamps, Incandescent Lamps, Alternating and Direct Current Motors and general electrical supplies. The engineers of this concern have for years made a special study of electric lighting. The new company will therefore occupy a foremost rank in the field of electrical illumination.

LIST OF BRANCH OFFICES

ATLANTA, GA	Empire Building
BOSTON, MASS	Oliver Building
CHICAGO, ILL	Monadnock Block
CINCINNATI, O	First National Bank Building
NEW YORK, N. Y	29 Broadway
PHILADELPHIA, PA	North American Building
ST. LOUIS, MO	Century Building
SAN FRANCISCO, CAL	69-75 New Montgomery Street
SEATTLE, WASH	Pioneer Building
MEXICO CITY, MEXICO	V. M. Braschi & Co.

SUPPLY AGENTS

BUTTE, MONT	Montana Electric Co.
DENVER, COLO	Hendrie & Bolthoff Mfg. and Supply Co.

Lillibridge, N. Y. 25-6549

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